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erals. Just why columbium and tantalum do not find a place here for the same reason is not altogether clear; but of course a limit had to be set.

Part I. classifies the minerals as follows: (1) silicates; (2) titano-silicates and titanates; (3) tantalo-columbates; (4) oxides and carbonates; and (5) phosphates and halides. Such a classification of the one hundred and fifty or more rare-earth minerals, giving the percentages of the chief rare earths present, is useful and has already been adopted by other authors. A valuable addition to this list is the giving of the locality where the minerals are found.

Part II. discusses adequately and satisfactorily, on the whole, the chemistry of the elements. A fair amount of attention is given to the separation processes so many and complicated in this group. The spectroscopic methods, absorption, spark, arc and cathode luminescence, methods themselves of the highest value, are duly emphasized, and Urbain's recent application of magnetic susceptibility receives its proper consideration. It is of interest to note that the lanthanum test consisting of a blue color when iodine is brought into contact with the hydroxide find a place in the book, although no one of whom the reviewer knows has been successful in applying it.

Part III. is concerned mainly with an account of the development of the incandescent light industry. This is a most instructive history, and deserves all the space assigned to it, as it has given the main impetus to rare-earth investigation during the past thirty years.

A feature which commends the book is its international scope. American, English, French and German chemists will find their work fairly represented.

The book is an important contribution to inorganic chemistry, and should be in the library of every inorganic chemist for study or at least for reference.

PHILIP E. BROWNING

Relativity and the Electron Theory. By E. CUNNINGHAM. Longmans, Green and Company, London. Pp. vii + 96.

The author has a large work on this subject printed by the Cambridge University Press and now presents a short monograph, from which the more difficult mathematical work is omitted. The result is a book which may be read without serious effort, even by persons not specialists in the theory of relativity or in mathematical physics. The titles of the chapter are: I. Introductory; II. The Origin of the Principle; III. The Relativity of Space and Time; IV. The Relativity of the Electro-magnetic Vectors; V. Mechanics and the Principle of Relativity; VI. Minkowski's Four-Dimension Vectors; VII. The New Mechanics; VIII. Relativity and an Objective *Æther*. Throughout the work emphasis is laid upon the physical foundations of relativity and upon its physical consequences. Something is also said of the philosophical meaning of relativity.

The natural book with which to compare Cunningham's is Carmichael's Monograph, "The Theory of Relativity," published by John Wiley and Sons. The essential element of contrast is that Carmichael proceeds in the Euclidean fashion from definite assumptions or postulates to definite theorems; whereas Cunningham writes in the ordinary style of the physicist. The one lays greater stress on logical foundation, the other upon the physical connections of the theory. So different is the point of view that even though the results overlap to a large extent, any reader of one of the monographs would find much additional interest in reading the other. The change in the concepts of mass and time and space which is suggested by the theory of relativity is so perplexing to many persons that the reading of both these texts will be none too much to allay their anxieties. The mathematician should begin with Carmichael and the physicist with Cunningham.

EDWIN BIDWELL WILSON

SPECIAL ARTICLES

THE RELATION OF OSMOTIC PRESSURE AND IMBIBITION IN THE LIVING MUSCLE

1. A SERIES of independent observations by Nasse, the writer, Overton, Meigs, Beutner,

v. Körösy, and probably others, have shown that the striped living muscle of a frog neither loses nor absorbs water when put into the solution of any sugar or neutral salt whose osmotic pressure is equal to that of a $m/8$ NaCl solution, provided the salt does not injure the membrane.¹ If the solution surrounding the muscle has a higher osmotic pressure the muscle will lose water, if it has a lower one the muscle will take up water. The normal, living muscle acts, therefore, as if it were surrounded by an ideal semipermeable membrane which allows water to pass through while it is impermeable for the neutral salts or sugars. The accuracy with which the muscle responds to slight changes in the osmotic pressure of the surrounding solution in the neighborhood of the isotonic point is so great that this response might be used to determine roughly the molecular weight of sugars or neutral salts. Since there is only one variable in which the isosmotic solutions of different sugars and salts of the same osmotic pressure agree, namely the number of molecules in the unit volume of the solution, we are forced to assume that the osmotic pressure is the driving force for the exchange of water between muscle and surrounding solution, provided that the surrounding solution does not destroy the semipermeability. This is not only true for the striped muscle, but also for the nerve (A. P. Mathews), for the excised kidney (Siebeck), for the red corpuscles (Hedin and others), for the sea-urchin egg (Loeb), and probably generally. The only exception known is the smooth muscle (Meigs).

2. In 1898 the writer² called attention to the rôle of acid formation in the muscle upon the absorption of water. He had found that if the muscle lies for a number of hours in an isotonic solution of NaCl the muscle begins to absorb small quantities of water (p. 462) and he ascribed this effect to the formation of acid (p. 464), probably lactic acid, in the muscle.

¹A fuller discussion of these experiments is found in SCIENCE, 1913, XXXVII., 427.

²Loeb, J., *Arch. f. d. ges. Physiol.*, 1898, LXXI., 457.

He also interpreted the rapid absorption of water by an active muscle in an isotonic solution to an absorption of water due to an acid formation, and he pointed out that absorption of water due to acid formation might play a rôle in phenomena of growth (p. 466) as well as in certain phenomena of edema (p. 467 ff.). The main phenomena of edema discussed by the writer in his paper have since been shown by Moore to be due to circulatory disturbances.³

The question remains, how the formation of lactic (or any other) acid can increase the absorption of water in the muscle. The writer assumed that this was due to an increase in the osmotic pressure of the muscle as a consequence of the acid formation; and this idea is, as he believes, correct. The only point in which his views as expressed in 1898 may require a modification concerns the way in which the formation of lactic acid (or of acid in general) increases the osmotic pressure of the muscle. In 1898 he assumed that the hydrogen ion acted like a hydrolytic ferment and increased the number of molecules in solution in the muscle by splitting certain larger molecules into smaller ones. This is, of course, *a priori* possible, but not proven in this case. A second possibility is the increase of the osmotic pressure of certain colloids under the influence of acid as observed by R. Lillie, Moore and Roaf, and others. A third possibility is connected with the explanation of imbibition given by the work of Procter, Pauli, and very recently Katz. According to this work we may assume that through a chemical combination of the acid with a protein the latter forms definite hydrates with water, in which process a diminution of volume with heat production occurs. If acid is formed in the muscle the proteins of the latter combine with the acid and with water. The number of molecules of water which one molecule of acid-protein (or rather one protein-cation) can bind seems considerable. This water is taken not from the outside, but from the solution inside the muscle. As a consequence of this

³Moore, A. R., *Am. Jour. Physiol.*, 1915, XXXVII., 220.

withdrawal of water the solution inside the muscle becomes more concentrated and assumes a higher osmotic pressure than that of a $m/8$ NaCl solution. Hence if such a muscle is surrounded by a $m/8$ NaCl solution the difference in osmotic pressure of the solution inside and outside the muscle must lead to a diffusion of water into the muscle.

The *direct* driving force for the exchange of water between muscle and surrounding solution is, therefore, again the osmotic pressure.

3. These ideas are so self-evident that their publication would seem superfluous were it not for the fact that Wolfgang Ostwald and other colloid chemists deny the existence of semipermeable membranes in the muscle on account of the fact that acid causes proteins to undergo imbibition. It seemed, therefore, of some importance to point out that the imbibition of the proteins of a muscle under the influence of acid formed inside contradicts neither the existence of a semipermeable membrane around the striped muscle nor the paramount rôle of osmotic pressure in the exchange of water between such a muscle and its surrounding solution.

JACQUES LOEB

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SOCIETIES AND ACADEMIES

THE KANSAS ACADEMY OF SCIENCE

THE forty-eighth annual meeting was held in Memorial Hall at Topeka, Kansas, January 14 and 15, 1916. The following, among other papers, were read:

"Civilized Europe: a Chapter in Anthropology," by A. A. Graham.

"Botanical Notes," by L. C. Wooster.

"Some Experiments with *Bacillus coli communis*," by L. C. Wooster.

"Observations on Jupiter at Opposition in 1915," by Edison Pettit.

"A Universal Helio-stat," by Edison Pettit.

"Additions to Kansas Coleoptra, to 1916," by W. Knaus.

"Some Life History Notes on *Phytonomus eximius*," by W. Knaus.

"Rare Coleoptra from the Sand Hill Region of Reno County," by W. Knaus.

"The Clan System of Wyandot Indians," by William E. Connelley.

"Echinacea and its Use," by J. M. McWharf.
Presidential Address—"American Highways," by J. A. G. Shirk.

"Properties of Kansas Clays," by Paul Teetor.

"Notes on the Comanchian of Kansas," by W. H. Twenhofel.

"Relative Toxicity of Aromatic Oils and Inorganic Compounds on Fungi," by L. J. Reiser.

"The Gorship Indians of Utah," by A. B. Reagan.

"Some Nutritional Characteristics of Corn," by J. T. Willard.

"The New Public Health," by J. C. Crumbine.

"A Study of Foods for Infants," by Leon A. Congdon.

"Stramonium," by L. D. Havenhill.

"The Chemical Products of Physical Fatigue and their Possible Relation to Mental Efficiency," by F. C. Dockeray.

"A Method for the Determination of Salicylic Acid in Aspirin," by G. N. Watson.

"Isolation of the Toxic Principles of Coffee and Determination of their Toxicity," by L. E. Sayre.

"Calcium Metabolism," by C. F. Nelson.

"Differentiation within the Acid-fast Group of Organisms," by N. F. Sherwood.

"Breeding Habits of some Annelids," by W. J. Baumgartner.

"Eugenic Studies in Kansas," by W. R. B. Robertson.

"Effect of Environment upon the Germ Cells," by B. M. Allen.

"Population Changes and Industrial Development," by P. F. Walker.

"Explosions in Kansas Coal Mines: Their Cause and Prevention," by A. C. Terrill.

"More about Kaw Lake," by J. E. Todd.

"Eolian Loess," by J. E. Todd.

"On the Occurrence of Starch in some Green Fruit Products used for Jelly-making," by E. H. S. Bailey and W. S. Long.

"The Chemical Characteristics of Ground Water," by F. W. Bruckmiller.

"Experimental Modifications in the Development of the Germ Glands of the Frog," by W. W. Swingle.

The officers elected were as follows: J. E. Todd, *President*; F. G. Agrelius and L. D. Havenhill, *Vice-presidents*; W. W. Swingle, *Secretary*; and Wm. A. Harshbarger, *Treasurer*.